

## A New Species of *Ledermanniella* (Podostemaceae) from Cameroon

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A new species of Podostemaceae subfamily Podostemoideae, *Ledermanniella ntemensis*, is described from southwestern Cameroon. It is characterized by the sparse scales on the shoot branches and the three stigmas.

Key words: Africa, Cameroon, *Ledermanniella ntemensis*, Podostemaceae

The taxonomy of Podostemaceae *s.lat.* (including Tristichaceae) of Cameroon was investigated to better understand the diversity of the family in Africa, the world's second center of distribution (Taylor 1953, 1954, van Steenis 1981, Cusset 1987). In her treatment of the family, Cusset (1987) recorded 20 species of *Ledermanniella* (in total ca. 46 species), the largest genus in the Old World (Cook 1996, Cook & Rutishauser 2007). Recently, two new species of *Ledermanniella* and a new species of *Stonesia* were added (Cheek 2003, Schenk & Thomas 2004, Pfeifer *et al.*, in press). At present, 11 genera (*Dicraeanthus*, *Djinga*, *Ledermanniella*, *Leiothylax*, *Letestuela*, *Macropodiella*, *Saxicolella*, *Stonesia*, *Tristicha*, *Winklerella*, *Zehnderia*) and 38 species are recorded from Cameroon, which is the most species-rich region in Africa (Ameka *et al.*, submitted). In the first molecular phylogenetic analysis of African Podostemoideae, Moline *et al.* (2007) showed that *Ledermanniella* is a paraphyletic group. Compared with Podostemoideae, the African and

American Tristichoideae consist of only *Tristicha trifaria* (Bory ex Willd.) Spreng. Populations of western Africa, e.g., Cameroon and Ghana, are hypothesized to have included a source population that gave rise to American populations by a single migration (Kita & Kato 2004, Y. Kita, unpubl. data).

In this paper, as a result of recent field work, we describe a new species assignable to the genus *Ledermanniella* subgenus *Phyllosoma*.

### Materials and Methods

New materials of Podostemaceae were collected on our field trips for taxonomic studies in Cameroon in 2002, 2004 and 2007. The materials include plants new to science, one of which we describe here as a new species. Additional specimens, together with herbarium specimens collected in Cameroon, were also used for comparison. The specimens used in this study are deposited in the Herbarium of National Museum of Nature

and Science, Tsukuba (TNS) and in the National Herbarium of Cameroon (YA). We also examined specimens deposited in the Herbar Laboratoire de Phanérogamie, Muséum National d'Histoire Naturelle, Paris (P).

For scanning electron microscopic (SEM) observations, dried material was dehydrated in an ethyl alcohol series, soaked in isoamyl acetate, critical-point dried with an HCP-2 (Hitachi, Tokyo), sputter coated with platinum-palladium using a JFC-1200 (Jeol, Tokyo), and observed in a

JSM-5410LV (Jeol, Tokyo) at 5 kV.

## Taxonomy

**Ledermanniella ntemensis** Y. Kita, Koi, Rutish. & M. Kato, **sp. nov.** (Figs. 1–3)

A consubgeneribus subgeneris *Phyllosomatis* foliis laciniatis, segmentis filiformibus, stigmatibus 3 differt.

*Typus.* Cameroon. Rapids of Ntem river, 2 hr by motorboat from Campo beach, 2°14'N, 9°52'E, R. Imaichi, Y. Kita & J.-P. Ghogue CMR-65 (TNS).



FIG. 1. Distal part of fruiting plant of *Ledermanniella ntemensis* (Imaichi et al. CMR-65 [TNS]). Scale bar = 5 mm.

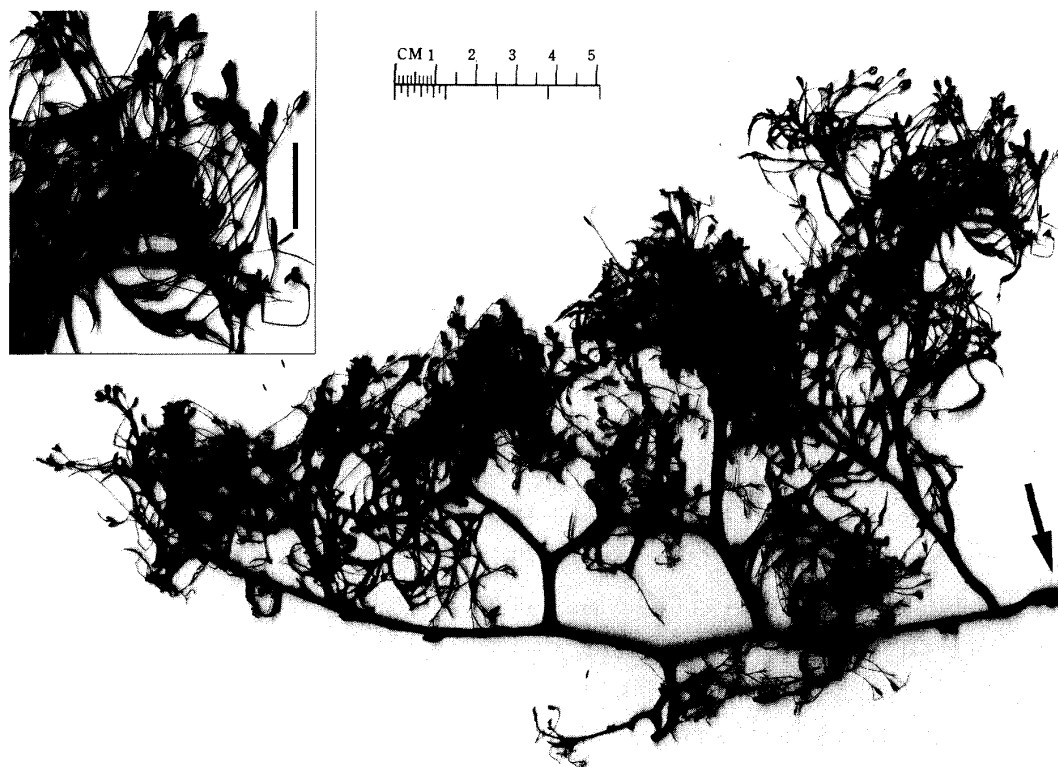


FIG. 2. Photograph of *Ledermanniella ntemensis*, with magnification of ultimate and penultimate branches (inset, scale bar = 1 cm) (Imaichi et al. CMR-65 [TNS]). Arrow indicates base of plant attached to rock substrate.

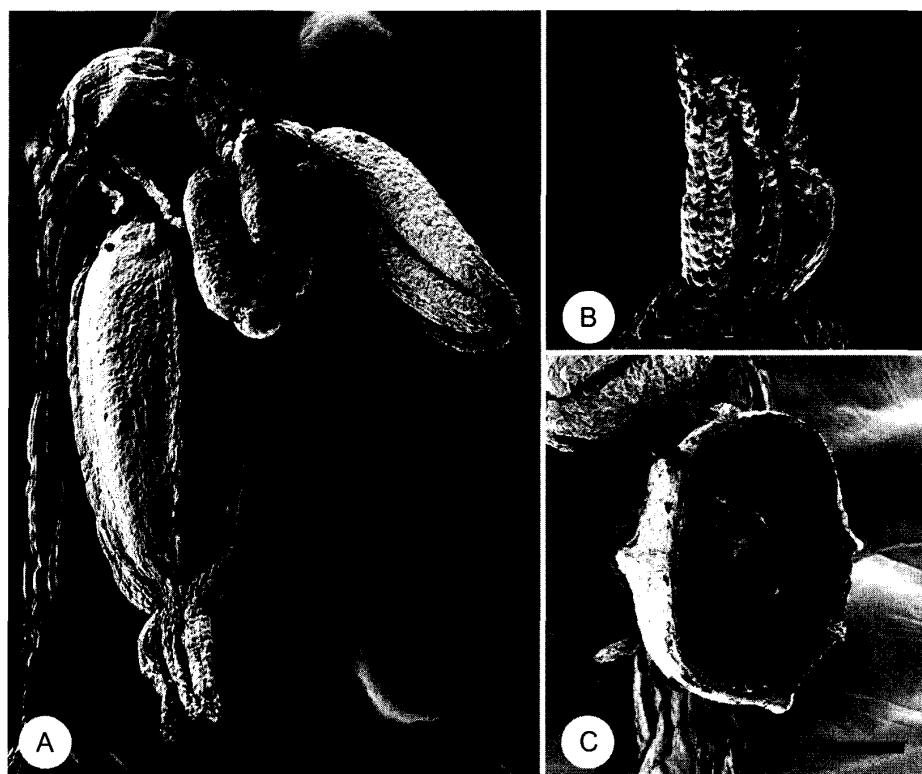


FIG. 3. SEM images of young *Ledermanniella ntemensis* flowers (Imaichi et al. CMR-65 [TNS]). The flowers are exposed by removing spatheas, in which they were embedded. A: Inverted flower comprising ribbed ovary with three stigmas and forked stamens on pedicel. B: Three stigmas. C: Cross section of unilocular ovary with ovules on central placenta. The ovary is distorted by cutting. Scale bars = 0.5 mm in A, 0.1 mm in B, C.

Herbs, annual, submerged, rheophytes, attached to rock by disk-like base, several times branched, anisotomous or rarely isotomous, to 35 cm long, to 25 cm wide, axes 1–2 mm thick, sparsely scaly or spinulose. Leaves on ultimate branches finely dissected, ca. 0.1 mm thick or thinner, leaflets hair-like, sparsely scaly at base, scales ligulate, 0.5–0.8 mm long, ultimate branches sometimes remaining as scaly buds at base of flower (apparently bract-like); ultimate and penultimate fertile branchlets sparsely scaly, scales variable, semi-circular, triangular or ligulate, 0.7–1.0 mm long. Flowers green or reddish (from note on label of *R. Letouzey 15333*), abundant on ultimate branches, solitary in axils between branches, inverted while enclosed in spathella; bract absent, spathella membranous, 4–8 mm long, dehiscing at apex at anthesis, funnel-like, mouth lobed with several deltoid segments; pedicel 15–25 mm long; tepals 2, on either side of stamens at apex of pedicel, hair-like, ca. 1.5 mm long; stamens 2, filaments forked above or near middle, 5–7 mm long, often persistent; anthers oblong, 1.2–1.5 mm long; pollen grains monads; ovary 1, at apex of pedicel, stalked (stalk 1–2 mm long), narrowly ellipsoid, 2.5–3 mm long, 0.5–0.8 mm thick, 1-locular; stigmas 3 (middle stigma between ordinary stigmas slightly shorter), erect or oblique, rarely reflexed, 0.3–0.5 mm long, linear; placenta central, flat, free from ovary wall except at top and bottom ends, ovules borne on whole surface of placenta. Capsule as large as ovary, 8-ribbed, dehiscing by one, then two clefts, resulting in two equal, boat-shaped valves.

*Ecology and distribution.* On submerged or exposed rocks in waterfalls; only at Ntem waterfall, southwestern Cameroon. *Ledermanniella ntemensis* grows with *L. bifurcata* (Engl.) C. Cusset (subgenus *Ledermanniella*) (Cusset 1987).

*Specimen examined.* Cameroon. Ntem waterfalls near Bongola, 40 km ESE of Campo, *R. Letouzey 15333* (P).

*Notes.* Cusset (1987) cited *R. Letouzey 15333* (P), collected previously from the type locality of *Ledermanniella ntemensis*, as *L. bosii* C. Cusset. Comparison of this specimen, our collection and the type of *L. bosii* (*Bos 3592* [P]) and illustrations (Cusset 1983: pl. 9, f. 6–8, Cusset 1987: pl. 25) shows clearly that the two species are distinct in the sparse scales (vs. imbricate in *L. bosii*) on the ultimate fertile branches and penultimate branches, the longer pedicel of *L. ntemensis*, the longer stamen (ca. 3 mm in *L. bosii*), the 3 (vs. 2) and shorter (vs. 0.7–0.8 mm) stigmas, and pollen in monads (vs. dyads). The three stigmas were noted on the label of *Letouzey 15333* (P). A rudimentary additional stigma was reported elsewhere for *L. bowlingii* (J. B. Hall) C. Cusset (subgenus *Ledermanniella*) (Ameka *et al.* 2003). *Ledermanniella ntemensis* is distinct from all species referred to subgenus *Phyllosoma* in the sparse scales and three stigmas.

Cusset (1983, 1984) divided *Ledermanniella* into two subgenera, *Ledermanniella* and *Phyllosoma*. They are defined by the scales on the shoot (present in subgenus *Phyllosoma*, and absent in subgenus *Ledermanniella*). Molecular phylogenetic data (Y. Kita & S. Koi, unpubl.) indicate that *L. ntemensis*, *L. cristata* (type of subgenus *Phyllosoma*) and some others form a clade, while *L. bosii* is basal in the clade of subgenus *Phyllosoma*, although the support for the phylogeny is low. The genus *Ledermanniella* is paraphyletic because *Dicraeanthus*, *Djinga*, *Letestuella*, and *Macropodiella* are ingroups (Moline *et al.* 2007, Y. Kita & S. Koi, unpubl. res.). A large-scale phylogenetic analysis is needed for a taxonomic revision of *Ledermanniella* and related genera.

Branch and leaf are more or less arbitrary terms for plants of *Ledermanniella*; the homology of these organs and the scale remains to be clarified.

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## References

- Ameka, G. K., G. C. Clerk, E. Pfeifer & R. Rutishauser. 2003. Developmental morphology of *Ledermanniella bowlingii* (Podostemaceae) from Ghana. *Plant Syst. Evol.* 237: 165–183.
- Ameka, G. K., J.-P. Ghogue & R. Rutishauser. (submitted) Podostemaceae research in Africa—state of the art and open questions. Proceedings of XVIII AETFAT Congress. Yaoundé, Cameroon.
- Cheek, M. 2003. A new species of *Ledermanniella* (Podostemaceae) from western Cameroon. *Kew Bull.* 58: 733–737.
- Cook, C. D. K. 1996. *Aquatic Plant Book*. 2nd ed. SPB Academic Publishing, The Hague.
- Cook, C. D. K. & R. Rutishauser. 2007. Podostemaceae. In: Kubitzki, K. (ed.), *The Families and Genera of Vascular Plants*, Vol. 9, pp. 304–344. Springer, Berlin.
- Cusset, C. 1983. Contribution a l'étude des Podostemaceae: 7. *Ledermanniella* Engl. sous-genre *Phyllosoma* C. Cusset. *Bull. Mus. Natl. Hist. Nat., Paris*, 4<sup>e</sup> sér, sect. B, Adansonia 5(4): 361–390.
- Cusset, C. 1984. Contribution a l'étude des Podostemaceae: 8. *Ledermanniella* Engl. sous-genre *Ledermanniella*. *Bull. Mus. Natl. Hist. Nat., Paris*, 4<sup>e</sup> sér, sect. B, Adansonia 6(3): 249–278.
- Cusset, C. 1987. Podostemaceae and Tristichaceae. In: Satanié, B. & P. Morat (eds.), *Flore du Cameroun* 30: 51–101.
- Kita, Y. & M. Kato. 2004. Phylogenetic relationships between disjunctly occurring groups of *Tristicha trifaria* (Podostemaceae). *J. Biogeogr.* 31: 1605–1612.
- Moline, P., M. Thiv, G. K. Ameka, J.-P. Ghogue, E. Pfeifer & R. Rutishauser. 2007. Comparative morphology and molecular systematics of African Podostemaceae-Podostemoideae, with emphasis on *Dicraeanthus* and *Ledermanniella* from Cameroon. *Int. J. Plant Sci.* 168: 159–180.
- Pfeifer, E., V. Grob & R. Rutishauser. (in press) *Stonesia ghoguei*—peculiar morphology of a new Cameroonian species (Podostemaceae-Podostemoideae). *Novon*.
- Schenk, J. J. & D. W. Thomas. 2004. A new species of *Ledermanniella* (Podostemaceae) from Cameroon. *Novon* 14: 227–232.
- Taylor, G. 1953. Notes on Podostemaceae for the revision of the Flora of West Tropical Africa. *Bull. Brit. Mus. (Nat. Hist.)* 1(3): 53–79.
- Taylor, G. 1954. Podostemaceae. In: Hutchinson, J. & J. M. Daizel (eds.), *Flora of West Tropical Africa* 1(1): 122–127.
- van Steenis, C. G. G. J. 1981. *Rheophytes of the World*. Sijthoff & Noordhoff, Alphen aan den Rijn.

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